

# *School*

School Intervention  
Impact Model  
Version 2.0, December 1999

A tool to estimate the impact of  
HIV prevention activities focused on  
youth in school

December 1999

UNAIDS and the  
Health Economics and Financing Programme  
Health Policy Unit  
London School of Hygiene & Tropical Medicine



HIVTools  
A cost-effectiveness  
toolkit for policy makers



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## **School Intervention Impact Model Version 2.0, December 1999**

A tool to estimate the impact of HI V prevention  
activities focused on  
youth in school

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# 1. Introduction to model and project

## 1.1 Background

A collaborative research project between the UNAIDS and the Health Economics and Financing Programme at the London School of Hygiene and Tropical Medicine has been working since 1994 to develop methodologies to determine the costs and likely impact of five HIV prevention strategies - the strengthening of blood transfusion services, condom social marketing projects, school education, the strengthening of sexually transmitted infections (STI) treatment services, and interventions working with sex workers and their clients.

'*HIVTools*: a cost-effectiveness toolkit for HIV prevention' is currently being developed. *HIVTools* consists of: 1) a set of five simulation models that estimate the impact on HIV and STD transmission of different HIV prevention activities; and 2) guidelines for costing different HIV prevention activities. *HIVTools* aims to be a flexible and easy to use product, designed for policy makers, programme managers and AIDS Service Organisations working to address HIV and STI transmission. It can be used to estimate the impact, cost and cost-effectiveness of different HIV prevention strategies in different settings.

*School* is one of the simulation models within *HIVTools*. *School* can be used, within a particular setting, to estimate the impact on HIV transmission of interventions focusing on youth enrolled in school. It can also be used to explore the likely impact of different policy options. The program simulates the transmission of HIV and STI infection between male and female in school youth, male and female out of school youth, and older males and females, both in the presence and absence of an intervention. Individual youth enter the population being modeled as they start to have casual sexual partnerships, and may leave either if they enter a regular partnership or due to HIV related severe morbidity. The extent to which a school-based intervention may avert HIV infection is estimated using a range of context specific inputs. This includes epidemiological information describing the prevalence of HIV infection among youth in school and their older sexual partners at the start of the intervention, and the probabilities of HIV and STI infection. Behavioural inputs are used to describe the patterns of sexual behaviour and condom use among youth reached and not reached by the school intervention. Demographic and intervention specific inputs are used to estimate the size of the total youth population, the proportion of males and females enrolled in school, and the proportion of each reached by the intervention. These are then used to project the overall patterns of sexual behaviour and condom use among youth with and without the intervention.

The modelling approach adopted for *School* differs from that taken by a number of other research groups, whose models focus on simulating the long term demographic impact of HIV infection, and are used to project long term trends in HIV prevalence and incidence. In contrast, from conception, the aim was that *School* would be a relatively simple tool that could be used to provide applied, intervention specific insights of use to Program Managers and policy makers at the national and local level. For this reason, the model's

structure has intentionally been kept as simple as possible, and geared towards using the routine forms of monitoring and evaluation data currently being collected by interventions focusing on youth in school. The model has a selected range of inputs, linked to the main factors thought to influence the impact of an intervention. As more information becomes available, it may be necessary to modify the program's structure to reflect changes in understanding.

It is hoped that *School* can be used to improve understanding of the impact of interventions focused on youth in school, to identify some of the key features influencing their impact in different settings, and to inform policy.

## 1.2 Key features of *School*

- ❑ A dynamic mathematical model of the transmission dynamics of HIV and STI infection between male and female in school youth, male and female out of school youth, and older male and females. The model can be used to obtain:
  - short-term estimates of the number of HIV infections averted among in and out of school youth;
  - trends in HIV and STD infection in the presence and absence of an intervention;
  - trends in HIV incidence in the presence and absence of an intervention;
  - trends in HIV infection among in and out of school youth.
- ❑ *School* aims to use the forms of behavioural, epidemiological and intervention process and outcome data that are commonly collected by interventions working with youth in school.
- ❑ *School* incorporates a range of intervention specific inputs, which enable the user to explore the short term effects of different forms of intervention activity on the overall patterns of HIV and STI transmission among in and out of school youth, and the numbers of HIV infections averted over a specified time.
- ❑ *School* is a self-contained piece of computer software, that aims to be user friendly to a broad range of individuals concerned about HIV transmission among youth.

The model incorporates a range of ways in which the in-school intervention may alter patterns of HIV transmission:

- Increase the age at which boys and/or girls start sexual activity;
- Decrease the numbers of sexual partners of boys and/or girls
- Reduce the extent to which boys and/or girls have older sexual partners

- Increase the consistency of condom use in boys/girls/older person partnerships
- Increase the average consistency of condom use in boy/girl partnerships
- Increase the coverage of the intervention among in-school youth.

### 1.3 Development of *School*

*School* was developed by the Health Economics and Financing Programme, London School of Hygiene and Tropical Medicine, with financial support from UNAIDS and The Department for International Development.

The initial structure of the model developed is the result of a series of consultations with staff at UNAIDS, and followed a review of the literature on school interventions. Simple flow charts were used to describe the model structure and underlying assumptions. These were used to enable a range of groups to guide the model's structure. The model and its underlying assumptions were field tested in Cameroon in 1996. Informal discussions with key informants, and the findings from several epidemiological, behavioural and evaluation studies, were used to assess the relevance, applicability and ease of use of the model. Further field-testing will be required to assess the more general applicability of the model, and to refine its format to the needs of specific users.

## 1.4 Model outline

The program simulates the transmission of HIV and a generic STI between in school youth, out of school youth and youth with older sexual partners, both in the presence and absence of an intervention. The impact of the intervention is determined using context specific epidemiological data, estimates of the coverage of the project among the overall sexually active youth population (excluding those in regular partnerships), estimates of the effect of intervention contact on reported levels of sex with same-age and older sexual partners, and the levels of condom use with these different groups.

Demographic, behavioural and intervention processes and outcome evaluation data are used to estimate:

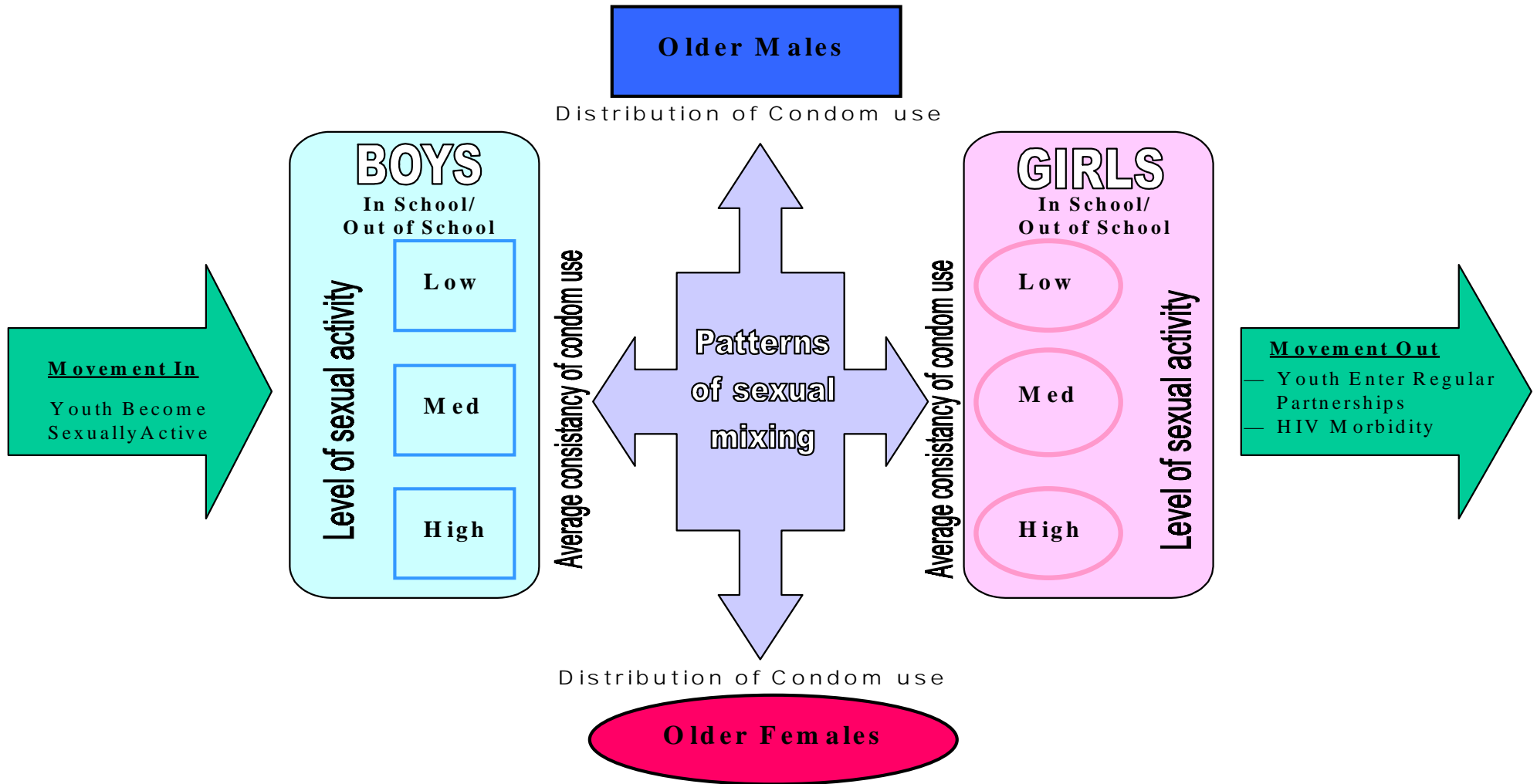
1. The total size of the sexually active youth population in the city or location of interest.
2. The numbers of boys and girls recently reached by the school intervention.
3. The impact of the intervention on:
  - the numbers of boys and girls who are sexually active (and not in a regular partnership);
  - levels of sexual activity;
  - patterns of mixing between youth and older sexual partners;
  - the consistency of condom use in youth-youth partnerships;
  - the distribution of condom use in youth-older person partnerships.

For example, the distribution of condom use among sexually active youth in the presence of the intervention is calculated using inputs describing:

- ❑ the size of the sexually active youth population;
- ❑ the proportion enrolled in school;
- ❑ the proportion of those in school who have been reached by the intervention;
- ❑ information on the distribution of condom use among youth who have not been reached by the intervention;
- ❑ information on the distribution of condom use among youth who have been reached by the intervention.

Once the distribution of patterns of sexual behaviour have been estimated, the model then simulates the patterns of HIV and STI transmission resulting from sexual contact between three groups of boys, three groups of girls, and their sexual partners (see Figure 1). Boys and girls are divided into three groups - those with low numbers of sexual partners, those with medium numbers of sexual partners, and those with high numbers of sexual partners. These in turn are divided into boys and girls with

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older sexual partners (such as sugar daddies or commercial sex-workers), and those without. Inputs describing patterns of condom use with older groups are used to estimate the proportion of boys and girls with older partners who use condoms 'all of the time', 'half of the time' or who are 'not using' condoms with them. The proportions in each sub-group is influenced by the baseline distribution of reported condom use, the extent to which the intervention reaches the overall population, and the degree to which contact with the intervention results in changes in reported condom use. The average consistency of condom use in youth-youth partnerships is estimated in a similar manner.

For simplicity, it is assumed that the sexual behaviour of boys and girls who are not in school is the same as the sexual behaviour of boys and girls in school who have not had contact with the intervention. This assumption reflects the lack of data on the sexual behaviour of out of school youth that is likely to be collected by in school youth interventions. Further revisions of the model may change this, and require inputs on the sexual behaviour of out of school youth.

Youth move into the population considered in the model as they start to have sex (at a specified average age for boys and girls). They move out of the population considered once they enter a regular partnership (at a specified average age), or due to HIV-related morbidity. Consequently, the population of sexually active youth may grow, stay the same size, or decrease in size after time.

The model includes the possibility of HIV and/or STI transmission from older sexual partners to susceptible youth. This is done using inputs describing a fixed prevalence of HIV and STI among older males and older females. The dynamics of HIV and STI infection among older sexual partners is not simulated, as this is likely to change as a result of sex with non-youth partners. Further revisions of the model may require inputs describing the annual HIV incidence among the older populations.

In the model, the sexually active male and female youth populations are sub-divided into sub-groups according to their levels of sexual activity (number of partners per year), levels of sexual contact with older partners, and levels of condom use. Each sub-group is then assumed to be homogeneous, and to randomly select sexual partners according to specified rules of mixing defined using the model's input parameters.

Because the transmission of HIV infection is facilitated by the presence of an STI, the model simulates how, over time, both a 'generic' STI and HIV infection may spread between older partners and youth, and between



youth in the presence and absence of the school intervention. As there is also an increased probability of HIV transmission during the initial high viraemia phase of HIV infection, at each point in time, HIV infected individuals are divided into those with early infections (in a high viraemia phase) and those with more long-term infections (in a low viraemia phase).

At present, the model simulates the patterns of HIV transmission among a youth population in the presence and absence of an intervention implemented at the early stages of infection among youth, when HIV prevalence levels are still very low.

*Section 3* describes in more detail the inputs required by the model. Details of the underlying mathematics are given in Vickerman and Watts (in preparation).

## 2. Installing and running *School 2.0*

### 2.1 Installing and opening *School 2.0*

Version 2.0 of *School* is a stand-alone program designed for use on an IBM-compatible computer. The program can be run in either a DOS (version 3.1 or higher) or a Windows environment. Version 2.0 was finalised in August 1999, and can be obtained free of charge from UNAIDS. Anyone who would like to receive up-dated copies of the model should write to LSHTM giving their contact details, and describing how they plan to use the model. They will then be sent the latest version of the model and an accompanying manual. It is likely that further revisions to the model will be made once feedback on its use has been obtained.

All of the files needed to run this program are on the floppy disk included with this manual. To install *School 2.0*, you need to run the file SETUP.EXE, included on the floppy disk.

#### Installing and opening from Windows 95, 97 or 98<sup>1</sup>

- Step 1. Close all running applications of HIVTools and insert the *School 2.0* disk in your floppy disk drive
- Step 2. In Windows Program Manager, choose Run from the [START] menu
- Step 3. Type 'a:\setup', where a: is the letter of your disk drive, and press [Enter]. This will start the installation process.
- Step 4. A dialog box [HIV Prevention Models Version 2.0 Setup] will appear on your screen. Use the mouse to select the [OK] button on the dialog box or press [Enter] to continue the installation process.
- Step 5. Another dialog box [COLLECTING SETUP INFORMATION ....] will then appear on your screen. This gives details of the location and name of the directory in which the *School 2.0* program files will be copied, the name of the program group in which the *School* program icon will be placed, and the location of the installation files. By default, the installation process will create a directory on your C: drive called 'Models', to contain the program files; and will create a program group 'HIV Prevention Models', in which to place the *School 2.0* program. The location and name of the directory, and/or the group name, and/or the location of the installation files

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<sup>1</sup> Windows 3.1, Windows 95, Windows 97 and Windows 98 are registered trademarks of Microsoft Corporation.

can be changed by entering a different drive, directory name and/or group name in the dialog box. Once you have made any desired changes, use the mouse to select the [NEXT>>] button on the dialog box or press [Enter] to continue.

- Step 6. A warning dialog box will now be shown on the screen, warning that the installation process cannot be completed if other applications of HIVTools are running. If necessary, use the [Alt]-[Tab] keys to switch to any open applications, and then close them. Once all other applications are closed, select the [OK] button or press [Enter] to continue with the installation process.
- Step 7. A dialog box will now be shown providing information on the progress made in installing *School 2.0*. At any point, you can select the [ABORT SETUP] or press [Esc] to terminate the installation process. Once installation is complete, a dialogue box [CONGRATULATIONS!] will appear on the screen, to inform you that the model has been successfully installed. Select the [OK] button or press [Enter] to exit the installation program.

To run the program, double click on the *School 2.0* model icon within the 'HIV Prevention Models' program group.

### Installing and opening from Windows 3.1<sup>1</sup>

- Step 1. Close all running applications of HIVTools and insert the *School 2.0* disk in your floppy disk drive
- Step 2. In Windows Program Manager, choose Run from the [FILE] option.
- Step 3. Type 'a:\setup', where a: is the letter of your disk drive, and press [Enter]. This will start the installation process.
- Step 4. Step 4. A dialog box [HIV Prevention Models Version 3.0 Setup] will appear on your screen. Use the mouse to select the [OK] button on the dialog box or press [Enter] to continue the installation process.
- Step 5. Another dialog box [COLLECTING SETUP INFORMATION ....] will then appear on your screen. This gives details of the location and name of the directory in which the *School 2.0* program files will be copied, the name of the program group in which the *School 2.0* program icon will be placed, and the location of the installation files. By default, the installation process will

create a directory on your C: drive called 'Models', to contain the program files; and will create a program group 'HIV Prevention Models', in which to place the *School 2.0* program. The location and name of the directory, and/or the group name, and/or the location of the installation files can be changed by entering a different drive, directory name and/or group name in the dialog box. Once you have made any desired changes, use the mouse to select the [NEXT>>] button on the dialog box or press [Enter] to continue

Step 6. A warning dialog box will now be shown on the screen, warning that the installation process cannot be completed if other HIVTools applications are running. If necessary, use the [Alt]-[Tab] keys to switch to any open applications, and then close them. Once all other applications are closed, select the [OK] button or press [Enter] to continue with the installation process.

Step 7. A dialog box will now be shown providing information on the progress made in installing *School*. At any point, you can select the [ABORT SETUP] or press [Esc] to terminate the installation process. Once installation is complete, a dialogue box [CONGRATULATIONS!] will appear on the screen, to inform you that the model has been successfully installed. Select the [OK] button or press [Enter] to exit the installation program.

To run the program, double click on the *School* model icon within the 'HIV Prevention Models' program group.

## Installing and opening from DOS

Step 1. Close all running applications and insert the *School 2.0* disk in your disk drive.

Step 2. Type 'a:' and press [Enter], where a: is the letter of your disk drive.

Step 3. Type 'a:\setup', where a: is the letter of your disk drive, and press [Enter]. This will start the installation process.

Step 4. A dialog box [HIV Prevention Models Version 3.0 Setup] will appear on your screen. Press [Enter] to continue the installation process.

Step 5. Another dialog box [COLLECTING SETUP INFORMATION ....] will appear on your screen. This gives details of the location and name of the directory in which the *School 2.0* program files

will be copied, and the location of the installation files. By default, the installation process will create a directory on your C: drive called 'Models', to contain the program files. The location and name of the directory, and/or the location of the installation files can be changed by entering a different drive, and/or group name in the dialog box. Once you have made any desired changes, press [Enter] to continue the installation process. Press [Esc] to terminate the installation.

Step 6. A warning dialog box will now be shown on the screen. This warns that the installation process cannot be completed if other applications are running. If necessary, use the [Alt]-[Tab] keys to switch to any open applications, and then close them. Once all other applications are closed, press [Enter] to continue with the installation process.

Step 7. A dialog box will now be shown providing information on the progress made in installing School. At any point, you can select the [ABORT SETUP] or press [Esc] to terminate the installation process. Once installation is complete, a dialogue box [CONGRATULATIONS!] will appear on the screen, to inform you that the model has been successfully installed. Press [Enter] to exit the installation program.

To run the program:

1. Type 'cd\models' and press [Enter] to change to the Model directory
2. Type 'school' and press [Enter] to run *School 2.0*.

## 2.2 Running *School*

Once *School 2.0* has been opened, a screen containing the Main Menu will appear:

### Selecting menu headings and menu items

Within a windows environment, the mouse can be used to select menu headings and menu items, to enter data, and to select the format in which to view the results. In addition, or when running *School* in a DOS environment, the following keys can be used:

**Arrow keys** The Up-Down and Left-Right arrow keys can be used to move up and down and between menu selections.

**ENTER key** The [Enter] key can be used to select menu options and to signal completed input of data into fields.

|                |   |
|----------------|---|
| <b>TAB key</b> | The [Tab] Key can be used to move in the forward direction between entry fields within any of the menu selection screens. Using both the [Shift] and [Tab] keys together allows movement in the reverse direction between entry fields.   |
| <b>ESC key</b> | The [Esc] key can be used to return to a higher menu level.   |
| <b>ALT key</b> | The [Alt] key, in combination with one of the letters underlined in the list of menu options, can be used to view the menu options. The [Alt] key, in combination with one of the letters underlined in the list of menu selections, followed by the [Enter] key, can be used to select the option. |

### 3. Menu headings

*School 2.0* has five primary menu headings: File, Values, Results, View and Help. These are described in turn below.

#### 3.1 FILE

Within [FILE], it is possible to open new parameter files, edit existing files, access the default values, and exit the program. [FILE] can be selected using either the mouse, or by pressing the [Alt] and F keys together. Options within [FILE] can then be selected by using the mouse; using the down arrow key to move the highlighted bar down to the option required and pressing [Enter], or by pressing the [Alt] and the appropriately lettered key together.

**File! Open** – can be used to locate and open saved files of input parameters. All input files for *School 2.0* have the extension NAME.sch. When *School 2.0* is opened, by default it will open the default parameter file. Existing files can be selected either by using the mouse, or by using the [Tab], arrow and [Enter] keys to move between folders and files.

**File! Save** – can, in the same manner, be used to save the current input parameters in the open parameter file. It is not possible to alter the input values assigned to the default data input file.

**File! Save as ...** – can be used to save the current input parameters in a new parameter file, with the extension NAME.sch. This can be used to develop, for example, files of input values from a school intervention being implemented in a particular setting.

**File! Print** - prints the current screen.

**File! Exit** - exits *School 2.0*.

#### 3.2 VALUES

The [VALUES] menu is used to change the input parameters used in the program simulations. Seven sets of inputs are required: computational, epidemiological, transmission, size youth, fixed behavioural, intervention effects. Within [VALUES], it is possible to modify the inputs used to estimate the impact of a particular

intervention. [VALUES] can be selected using either the mouse, or by pressing the [Alt] and [V] keys together. For illustration, the 'size youth and intervention effects' screen within [VALUES] are shown below.

|       | Average age youth start sex | Average age youth enter regular partnerships | Total number youth in age range |
|-------|-----------------------------|--|---------------------------------|
| Boys  | 16                          | 18   | 50000                           |
| Girls | 15                          | 17   | 50000                           |

|  | Boys | Girls |
|--|------|-------|
| Proportion youth in age range enrolled in school | 0.55 | 0.45  |
| Proportion youth in school reached by intervsn.  | 0.5  | 0.5   |

OK Cancel

Options within [VALUES] can be selected using the mouse; or by using the down arrow key to move the highlighted bar down to the option required, and then pressing [Enter]. Once an option within [VALUES] has been selected, a list of inputs will be shown. The input values shown can be selected and altered either by using the mouse, or by using the [Tab] key or the [Tab] and [Shift] keys together to move between different entry fields. By clicking the [OK] button or pressing [Enter], the user can exit the option and return to the [VALUES] menu. The input values shown at this point will be used in any subsequent calculations. More details about the [VALUES] menu are given in *Section 4*.

### 3.3 RESULTS

The [RESULTS] menu has only one option - [CALCULATE]. [RESULTS] can be selected using either the mouse, or by pressing the [Alt] and [R] keys together. [CALCULATE] can be selected either by using the mouse, or by first using the down arrow key to move the shaded bar to [CALCULATE], and then using the [Enter] key to select this option. The model will then use the current input parameter set to iteratively simulate over time patterns of STI and HIV transmission both in the presence and absence of the intervention. For School 2.0, the model simulates HIV transmission from low initial HIV prevalence levels among boys and girls.

### 3.4 VIEW



The outputs from a model simulation can be viewed in a number of ways. The projected trends in HIV and STI prevalence among different subgroups, with and without the intervention, can be viewed either in a data format or plotted on a graph. Estimates of the cumulative number of HIV infections averted by the intervention among boys and girls can also be viewed, in a data format and/or on a bar graph. The menu options within [VIEW] are listed below:

**View|Data outputs** - shows the main data outputs for each month in a table.

**View|Graphs** - the model output can be viewed in six different graphical forms, (see *Section 5.2*).

**View|Infections averted** - shows a summary bar-chart of the estimated number of HIV infections averted each year among sex workers and their clients over the timeframe being considered.

**View|Summary sheet** – gives a summary of the main inputs and model outputs.

**View|Flow charts** –shows the flow charts outlining the transmission dynamics underlying the model

### 3.5 HELP

The [ABOUT] option in the [HELP] menu gives a brief summary of the *School 2.0* model and contact details where more technical information about the model can be obtained. A more detailed [HELP] function has not been developed.

## 4. Model inputs

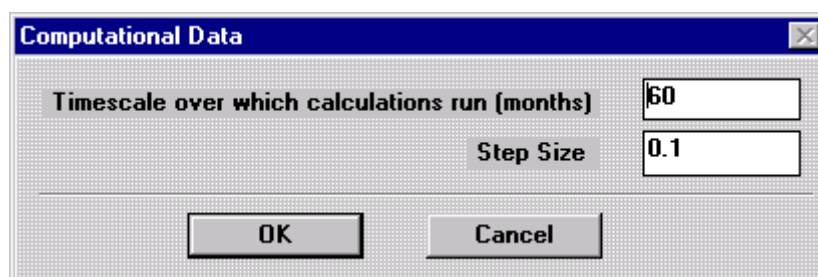
The model requires a range of input parameters, which are entered in the computational, epidemiological, behavioural, intervention coverage and impact, and transmission probability dialog boxes in the [VALUES] menu.

The [VALUE] menu can be used to change any of the input parameters used in the simulations. The mouse, arrow and return keys can be used to move between different input screens, and to change the model's inputs.

Where appropriate, limits on the possible range of different parameters have been specified in the model (such as proportions being greater than zero and less than one). Where a chosen number falls outside the permissible range, an error sign is displayed, and the user is given the option to input a different number. The model comes with a default set of pre-assigned behavioural, epidemiological and intervention specific inputs. Each time the program is opened, the set of input parameters revert to their default settings. Other sets of inputs can be saved in [FILE], under the header [SAVE].

Each of the dialog boxes are described below. The default values used are shown in the dialog boxes. A summary of the model inputs and default values are given in Appendix 1.

### 4.1 Computational Data - change computational inputs



- ❑ Timescale over which calculations run (months) – this is used to define how long to run the calculations. We do not recommend using timescales greater than five years (60 months).
- ❑ Step size (months) – this is used to define the time period used for each iterative calculation of the distribution of HIV and STD infection (see Appendix 2 for further explanation). In general, the smaller the step size used the better, and computational difficulties may arise if the step size used is too large. However, the use of too small a step size will result in the computations being slow. To identify an

appropriate step size to use, run the model with the default step size. Halve the step size, and run the model again. If the results do not differ substantially, you may continue with the larger step size. If the results are fairly different, you will need to again reduce the step size, and assess whether the results differ again. In this way, through trial and error, the most appropriate step size for any set of input parameters can be determined. This is discussed in more detail in Appendix 2.

#### 4.2 Epidemiological Inputs - change epidemiological inputs

| Epidemiological Inputs  |              |                |
|---|--------------|----------------|
| Average STI duration boys (months)                                      | 1            |                |
| Average STI duration girls (months)                                     | 1            |                |
| Average duration of high viraemia phase (months)                        | 1.5          |                |
| Average duration between HIV infection & severe morbidity               | 84           |                |
| <b>OLDER PARTNERS HIV &amp; STI PREVALENCE (%)</b>                      |              |                |
|   | <b>Males</b> | <b>Females</b> |
| HIV Prevalence  | 40           | 60             |
| STI prevalence  | 10           | 15             |
| Proportion with high viraemia   | 10           | 10             |
| <input type="button" value="OK"/> <input type="button" value="Cancel"/> |              |                |

- ❑ Average duration of STIs boys (months) - The average duration of STIs among boys. The duration chosen should broadly reflect the general accessibility and quality of STD treatment services available to boys.
- ❑ Average duration of STIs girls (months) - The average duration of STIs among girls. The duration chosen should broadly reflect the general accessibility and quality of STD treatment services available to girls.
- ❑ Average duration of initial high viraemia phase (months) - Average duration of the observed initial high viraemia phase of HIV infection. At present, it is not thought that this duration varies substantially between settings.
- ❑ Duration between HIV infection and morbidity (months) – Average time between acquiring HIV infection and ceasing sexual activity due to HIV related morbidity. This may vary between settings.

- ❑ Older partner HIV prevalence (fixed) – Average HIV proportion of male and female older partners of youth in schools HIV infected (range 0 to 1). The prevalence figures used should be taken to reflect the possible older groups having sex with youth in school. For example, in some settings the older female partners of boys in school may be sex-workers. The older male partners of girls in school may be men with multiple partners.
- ❑ Older partner STI prevalence (fixed) – Average proportion of male and female older partners of youth in schools, infected with a STI (range 0 to 1). In general the prevalence figure should include both ulcerative and non-ulcerative STIs. The co-factor should be weighted to reflect the relative prevalence of the different STIs.
- ❑ Proportion with high viraemia – Estimate of the proportion of HIV infected older male and female sexual partners who are in the high viraemia phase. This is likely to depend upon how well the HIV epidemic is established in the population – early on in the epidemic a greater proportion are likely to be in the high viraemia phase than when the epidemic is more generalised.

#### 4.3 Transmission probabilities - change HIV and STI transmission probabilities, the cofactor effect of STD infection, and the initial cofactor effect during the high viraemia of an HIV infection.

| Parameter   | Value |
|---|-------|
| Probability HIV transmission per sex act MALE TO FEMALE | 0.001 |
| Probability HIV transmission per sex act FEMALE TO MALE | 0.002 |
| Probability STI transmission per sex act both sexes     | 0.35  |
| Average STI cofactor per sex act                        | 30    |
| Multiplicative factor during high viraemia phase        | 10    |
| Condom efficacy per sex act                             | 0.9   |

- ❑ Prob transmission of HIV per sex act MALE TO FEMALE - Probability of transmission of HIV infection per sex act from males to females, in the absence of STIs, and/or high viraemia, when a condom is not used.

- ❑ Prob transmission HI V infection per sex act FEMALE TO MALE - Probability of transmission of HIV infection per sex act from females to males, in the absence of STIs, and/or high viraemia, when a condom is not used.
- ❑ Prob transmission of STI per sex act both sexes - Probability of transmission of STI infection per sex act for both sexes, when a condom is not used.
- ❑ STI cofactor effect per sex act - A multiplicative factor describing the extent to which the probability that HIV is transmitted is enhanced by either partner being infected with an STI per sex act. In practice, the value used can be taken to reflect the extent to which different forms of ulcerative and non-ulcerative STIs are common. Debate about the likely magnitude of the cofactor for different STIs is ongoing. Crudely speaking, the value used should reflect the relative prevalence of ulcerative and non-ulcerative STDs. In general though, a cofactor of 25-40 may be appropriate for settings where ulcerative STIs alone predominate, 15-25 in settings where both ulcerative and non-ulcerative STIs are common, and 5-15 in settings where non-ulcerative STIs predominate.
- ❑ Multiplicative factor during high viraemia phase - A multiplicative factor describing the extent to which the per sex act probability of HIV transmission is higher during the initial high viraemia phase of HIV infection.
- ❑ Condom efficacy per sex - A factor describing the extent to which the use of a condom reduces the per sex act probability of either HIV or STI transmission. The value used may differ between settings, and be chosen to reflect factors such as the quality of the condoms available, the degree to which condoms are used by people when drunk, or the degree to which instructions on condom use are provided. A factor of between 0.9-0.95 may be appropriate for settings where good quality condoms are used well, 0.7-0.9 for setting where good quality condoms are used by people when drunk, and 0.5-0.7 in settings where condoms are of poor quality, or reported levels of condom breakage are high.

#### 4.4 Size of youth population - changes behavioural inputs describing the size of the in and out of school youth population.

|       | Average age youth start sex | Average age youth enter regular partnerships | Total number youth in age range |
|-------|-----------------------------|--|---------------------------------|
| Boys  | 16                          | 18   | 50000                           |
| Girls | 15                          | 17   | 50000                           |

|  | Boys | Girls |
|--|------|-------|
| Proportion youth in age range enrolled in school | 0.55 | 0.45  |
| Proportion youth in school reached by interven.  | 0.5  | 0.5   |

OK Cancel

- ❑ Average age youth in-school start sex (years) - Average age at which boys and girls in school start sex. This is likely to differ both between locations, and between the sexes.
- ❑ Average age youth in-school enter regular partnerships (years) - Average age at which boys and girls enter regular partnerships. This is likely to vary substantially between locations and between boys and girls. This and the previous input affects the timeframe within which a youth is considered to be among the 'single', sexually active youth population considered in this model.
- ❑ Total number of youth in-school in age range – Average number of youth (boys, girls) in age range specified (i.e. between starting sex and entering regular partnerships).
- ❑ Proportion youth in-school – proportion of youth (boys and girls) in this age range(s) enrolled and regularly attending school.
- ❑ Proportion in school reached by the intervention – proportion of youth in-school adequately reached by the intervention. For example, if the intervention is implemented through a national curriculum, coverage may be high. In contrast, coverage may be relatively low if school education is being supported by NGOs working in a limited number of locations. In practice, the input value will depend on how 'adequate coverage' is interpreted. For example, in the behaviour change documented is a result of recent and/or regular contact with the intervention, the coverage measure used should also reflect this aspect.

These inputs can be changed to reflect the quality of the behavioural data being used in the simulations. For example, it may be that the reported use of condoms ‘all of the time’ is interpreted as 60% of the time, or 90% of the time. Sensitivity analysis can be used to assess the robustness of the model’s projections to changes in these assumptions.

#### 4.5 Fixed behavioural inputs - change the behavioural data used in the calculations. It is assumed that these inputs do not change as a result of the intervention

| Definition of low, medium and high number of partners per month |      | Definition of condom use, youth/adult partnership |      |     |
|---|------|---|------|-----|
|   | Boys | Girls   |      |     |
| 'Low'   | 0.5  | 0.5   | NONE | 0.1 |
| 'Med'   | 1    | 1   | SOME | 0.4 |
| 'High'  | 5    | 2   | ALL  | 0.9 |

Average no. sex acts per month for youth/youth relationships: 10

Average no. sex acts per youth/adult relationship: 5

Adjustment factor for differences in boys/girls reporting of sexual behaviour (range 0 to 1, 0 signifying the case when most confident with the male data and 1 being the opposite situation): 0.5

Level of like with like mixing between boys and girls by sexual activity (range 0 to 1, 0 being no like with like mixing, 1 being all like with like mixing): 0.5

OK Cancel

- Definition of low, medium and high numbers of partners per month – inputs used to describe the distribution in numbers of partners of sexually active boys and girls. In many settings the range may be quite large and the distribution relatively skewed: with the majority reporting only one partner, but with some reporting much higher numbers. These inputs require the total number of partners per month, irrespective of whether they are youth/youth or youth/adult partnerships.
- Definition of condom use, in youth / adult partnerships – definition of how to interpret behavioural data on the reported consistency of condom use by male and female youth with their older sexual partnerships.
  1. 'None' (between 0 and 0.2) - proportion of sex acts in which a condom is used that corresponds to when a youth reports that a condom has been used 'none of the time' with adult partners.

2. 'Half' (between 0.2 and 0.6) - proportion of sex acts in which a condom is used that corresponds to when a youth reports that a condom has been used 'half of the time' with older partners.
  3. 'All' (between 0.6 and 1) - proportion of sex acts in which a condom is used that corresponds to when a youth reports that a condom has been used 'all of the time' with adult partners.
- Average number of sex acts per month for youth / youth relationships
  - Average number of sex acts per month for youth / adults relationships
  - **Adjustment factor for differences in boys and girls reporting of sexual behaviour (ranging from 0 to 1).** Adjustment factor incorporated to reflect that there may be significant differences in the patterns of sexual behaviour reported by boys and girls. The discrepancy may be so large that it results in the total numbers of partners differing substantially. 0 signifies when the data from boys will be used, and 1 signifies when data from girls will be used. Measures in-between 0 and 1 reflects the relative confidence of the reported sexual behaviour of boys rather than girls.
  - **Levels of like with like mixing between boys and girls by sexual activity (ranging from 0 to 1).** Input parameter incorporated to reflect the patterns of sexual relationship between boys and girls with different levels of sexual activity. 0 represents no like with like mixing, 1 represents all like with like mixing. It is likely that this parameter will be difficult to estimate from intervention specific data. For this reason, sensitivity analysis should be used to explore the implications of the different mixing patterns on the overall patterns of sexual activity.



## 4.6 Intervention effects

These inputs describes the ways in which the intervention may alter patterns of HIV transmission.

### 4.6.1 Average age youth become sexually active (reached)

|       | Average age youth start sex | Average age youth enter regular partnerships |
|-------|-----------------------------|--|
| Boys  | 16                          | 18   |
| Girls | 15                          | 17   |

Average age youth (boys, girls) who are reached by the intervention become sexually active. Inputs describing the average age of youth in general are requested above.

| Distribution of boys levels of sexual activity (partners/month) |  | Not reached | Reached |
|---|--|-------------|---------|
| Low   |  | 0.5         | 0.6     |
| Medium  |  | 0.3         | 0.3     |
| High  |  | 0.2         | 0.1     |

| Distribution of girls levels of sexual activity (partners/month) |  | Not reached | Reached |
|--|--|-------------|---------|
| Low  |  | 0.7         | 0.8     |
| Medium   |  | 0.2         | 0.15    |
| High   |  | 0.1         | 0.05    |

### 4.6.2 Sexual activity of youth

- Distribution of boys levels of sexual activity (partners/month): Proportion of boys reached and not reached by the intervention reporting different levels of sexual activity ('low', 'medium' and 'high' numbers of partners per month). The information about boys not reached by the intervention can be an estimate by using pre-intervention baseline behavioural data. Alternatively, the information can be derived from similar boys that have not had contact or access to the intervention.
- Distribution of girls levels of sexual activity (partners per month): Proportion of girls

reached and not reached by the intervention reporting different levels of sexual activity (low, medium and high numbers of partners per month). The information about girls not reached by the intervention can be an estimate by using pre-intervention baseline behavioural data. Alternatively, the information can be derived from similar girls that have not had contact or access to the intervention.

- ❑ Adult partnerships
- ❑ Proportion of youth having adult partnerships

**Proportion of youth that have adult partnerships**

| Boys                     |        | Not reached | Reached |
|--------------------------|--------|-------------|---------|
| Level of sexual activity | Low    | 0.3         | 0.2     |
|                          | Medium | 0.5         | 0.4     |
|                          | High   | 0.7         | 0.6     |

| Girls                    |        | Not reached | Reached |
|--------------------------|--------|-------------|---------|
| Level of sexual activity | Low    | 0.2         | 0.15    |
|                          | Medium | 0.4         | 0.3     |
|                          | High   | 0.6         | 0.5     |

OK Cancel

Proportion of boys and girls with low, medium and high levels of sexual activity – among those reached and not reached by the intervention.

- ❑ Frequency of adult partnerships

**Proportion of partners that are adults given they have adult partners**

| Boys                      |        | Not reached | Reached |
|---------------------------|--------|-------------|---------|
| Levels of sexual activity | Low    | 0.2         | 0.1     |
|                           | Medium | 0.4         | 0.3     |
|                           | High   | 0.6         | 0.5     |

| Girls                     |        | Not reached | Reached |
|---------------------------|--------|-------------|---------|
| Levels of sexual activity | Low    | 0.1         | 0.1     |
|                           | Medium | 0.2         | 0.3     |
|                           | High   | 0.4         | 0.5     |

OK Cancel

Proportion of boys and girls reporting that they have older or adult sexual partners, according to their levels of sexual activity (low medium and high), and whether or not they have had contact with the intervention (reached / not reached).

### 4.6.3 Condom use in youth / adult partnerships

|  |  | Not reached |       | Reached |       |
|--|--|-------------|-------|---------|-------|
| Average consistency of condom use youth/youth partnerships |  | 0.2         |       | 0.6     |       |
| Distribution of condom use within youth/adult partnerships |  |             |       |         |       |
|  |  | Not reached |       | Reached |       |
|  |  | Boys        | Girls | Boys    | Girls |
| NONE   |  | 0.8         | 0.9   | 0.4     | 0.1   |
| HALF   |  | 0.1         | 0.05  | 0.2     | 0.4   |
| ALL  |  | 0.1         | 0.05  | 0.4     | 0.5   |

- ❑ Average consistency of condom use in youth / youth partnerships – averaged out among those reached and not reached by the intervention.
- ❑ Distribution of condom use among youth / adult partnerships - Proportion of boys / girls reporting using condoms with different levels of consistency (reached, not reached in youth/older partnerships).
  - a) NONE - Proportion of in school boys/girls reporting 'not using condoms' among those not reached and reached by the intervention.
  - b) HALF - Proportion of school boys/girls reporting using condoms 'half of the time' among those not reached and reached by the intervention.
  - c) ALL - Proportion of in- school boys/girls reporting using condoms 'all of the time' among those 'not reached' and reached by the intervention.

In each case, the 'not reached' figure may come from baseline behavioural information collected at the start of the intervention, or from similar boys/girls who have not had contact with the intervention. The 'reached' figure should come from behavioural evaluation data collected from boys and girls in school who have had recent contact with the intervention.

## 5. Model outputs

The output of the model is produced when the [CALCULATE] option is chosen from the [RESULTS] menu. The output of *School* can be viewed in a number of different formats as listed under the [VIEW] menu heading. These are described in turn below (also see *Section 3.4*).

## 5.1 Data outputs

Shows the main data outputs for each month in a tabular format. The table is shown using a program called '*CellViewer*' that is automatically opened once the [DATA OUTPUT] option within the [VIEW] menu is selected. The table has the following headings:

|           |  |
|-----------|--|
| Step      | Time since start of intervention (months)  |
| BPrev     | Projected HIV prevalence among youth in the absence of the intervention (S0, S1 and S2 denote low, medium and high sexual activity respectively and a and b denote whether they do not or do have older partners respectively) |
| Prev      | Projected HIV prevalence among youth (both boys and girls) in the presence of the intervention   |
| HIV avert | Cumulative HIV infections averted among youth as a result of the intervention  |

Within *CellViewer*, there is one menu heading [FILE]. The options within [FILE] can be used to save the data in a text file, print the data, or exit *CellViewer* and return to the main menu. Each of the menu options within [FILE] are described below, and can be selected using the mouse; using the down arrow key to move the highlighted bar down to the option required and pressing [Enter]; or by pressing the [Alt] key and the appropriately lettered key together.

File|Save as ... - Saves data as a text file, with the extension NAME.txt.

File|Print - Prints the data file

File|About - Gives more information about *CellViewer* - this has not been developed.

**File|Exit** - Exits *CellViewer* and the data output screen, returning the user to the main *School* menu.

## 5.2 Graphs

The model output can be viewed in six different graphical forms, described below. For each graph, the horizontal axis shows the timescale in months over which the calculations were made. The plots can be used to view a range of temporal trends in HIV prevalence HIV incidence and STI prevalence.

Each of the graphs is viewed using a program called *PlotView*, which is automatically opened once the [GRAPHS] option within the [VIEW] menu is selected. Within *PlotView*, there are two menu options: [FILE] and [VIEW]. The [FILE] menu can be used to rescale and print the graphs, and to exit *PlotView* and return to the main *School 2.0* menu.

Within *PlotView*, the [FILE] menu has the following options:

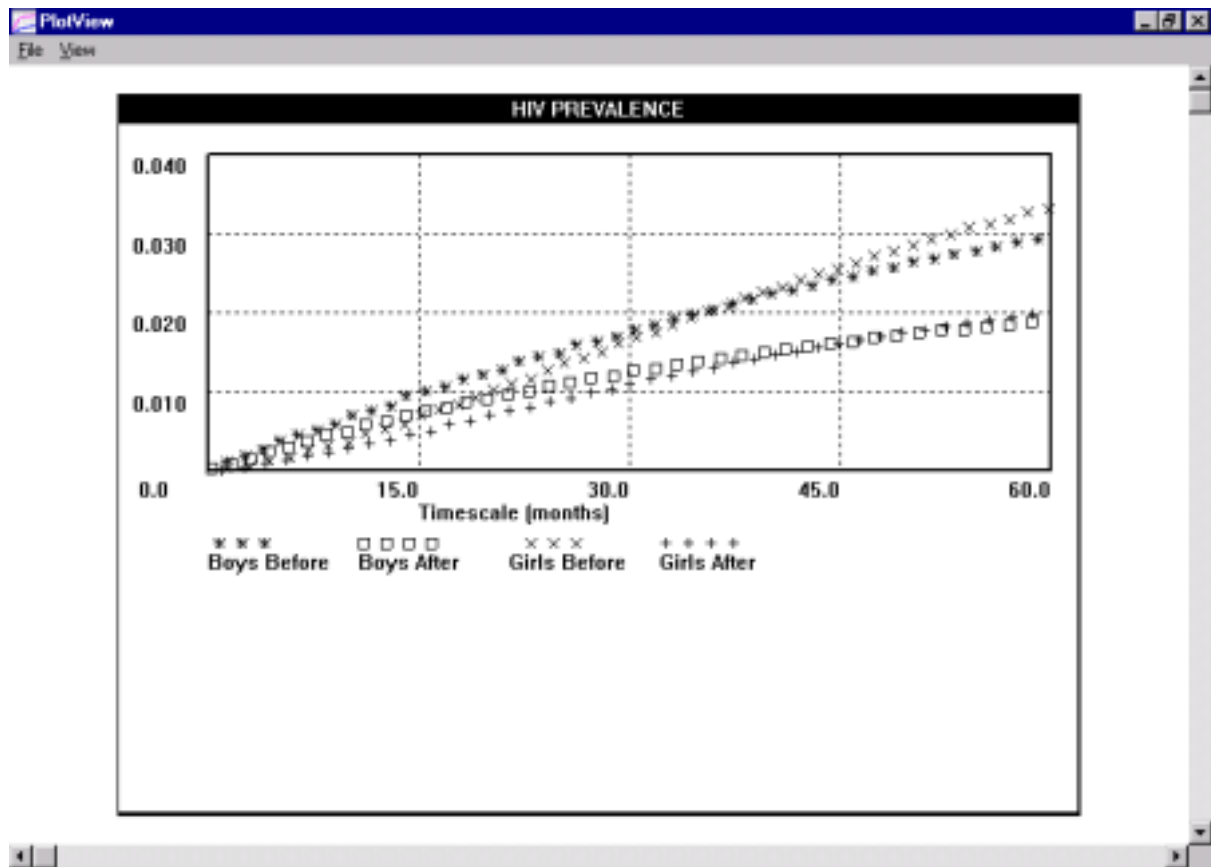
**File|Maximum Y** – Enables the user to rescale the plots shown by defining the maximum value for the vertical axis.

**File|Print** - Prints the current plot.

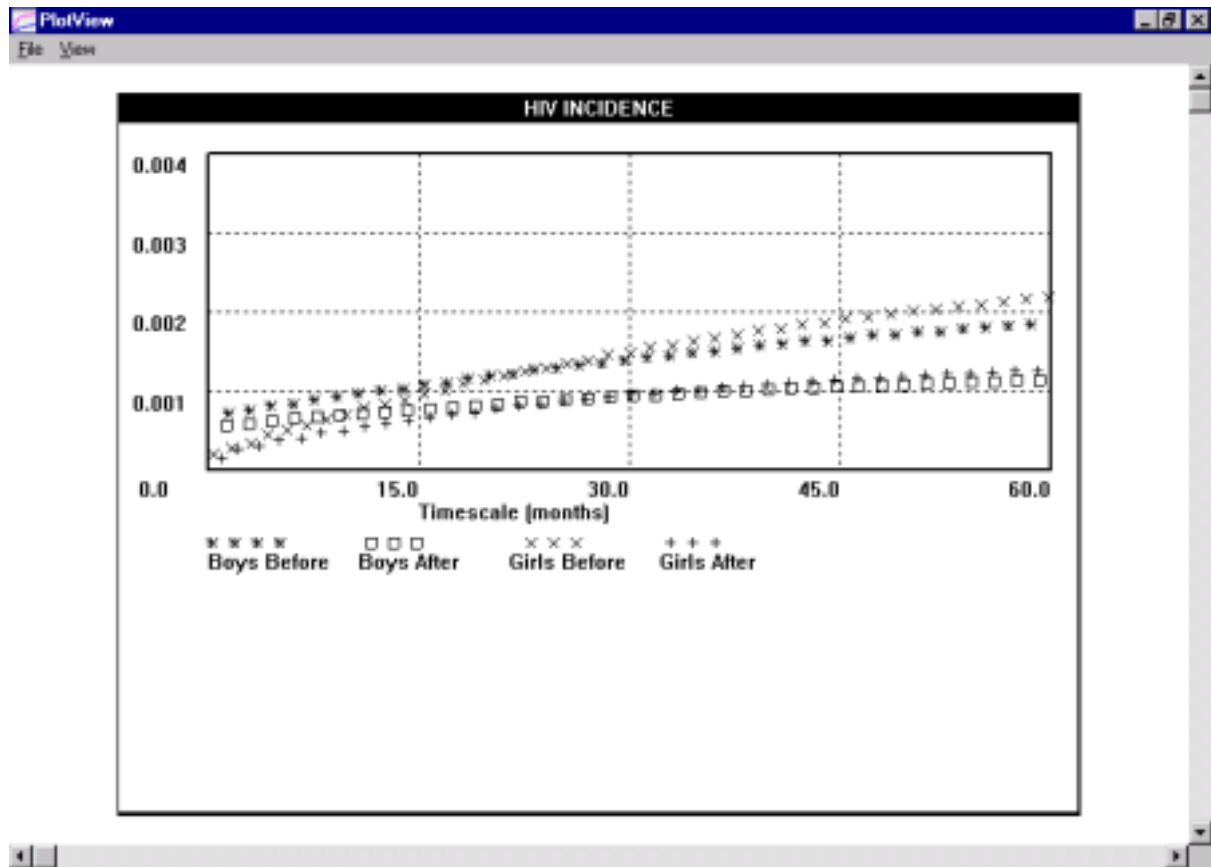
**File|Exit** - Exits *PlotView*, returning the user to the main *School* menu.

With *PlotView*, the [VIEW] menu can be used to select one of the pre-assigned plot formats for viewing the model outputs. These are described in turn below:

**HIV PREVALENCE** - plots a graph of the projected trends over time of HIV prevalence among boys and girls with and without the intervention. The graph shows the projected prevalence of HIV infection on the vertical axis, for boys and girls both in the presence (After) and absence (Before) of the intervention.

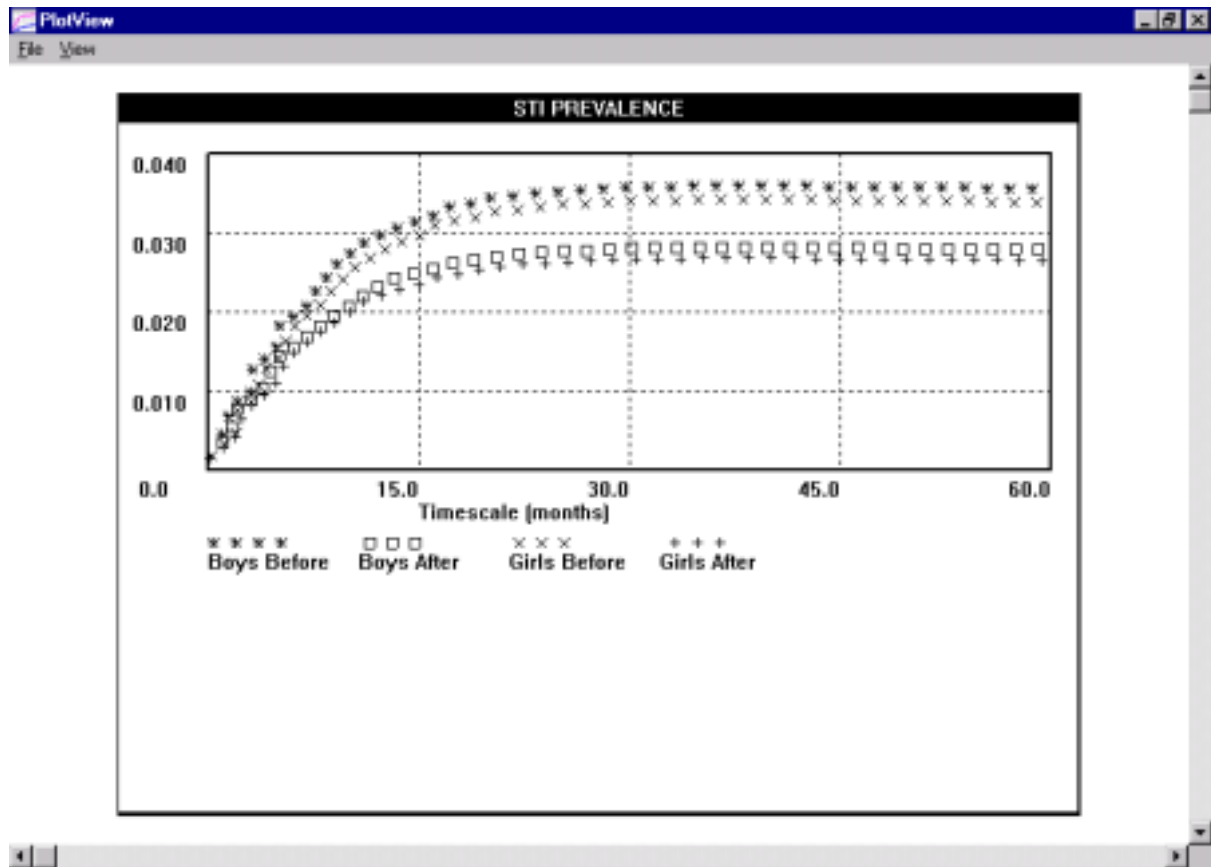


**HIV INCIDENCE** – plots a graph of projected trends over time of HIV incidence among youth. The graph shows the projected incidence of HIV infection on the vertical axis for boys and girls both in the presence (After) and absence (Before) of the school intervention. The vertical axis can be scaled to an appropriate value.

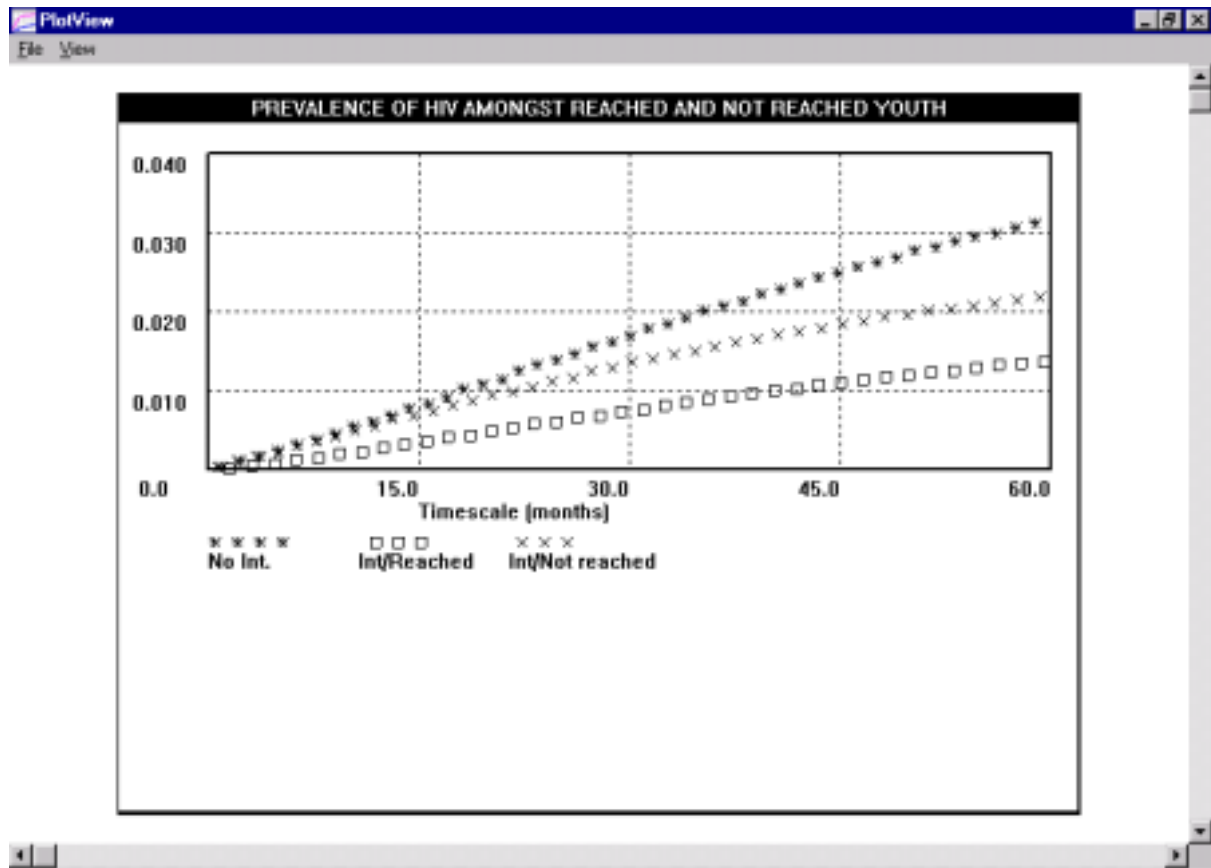




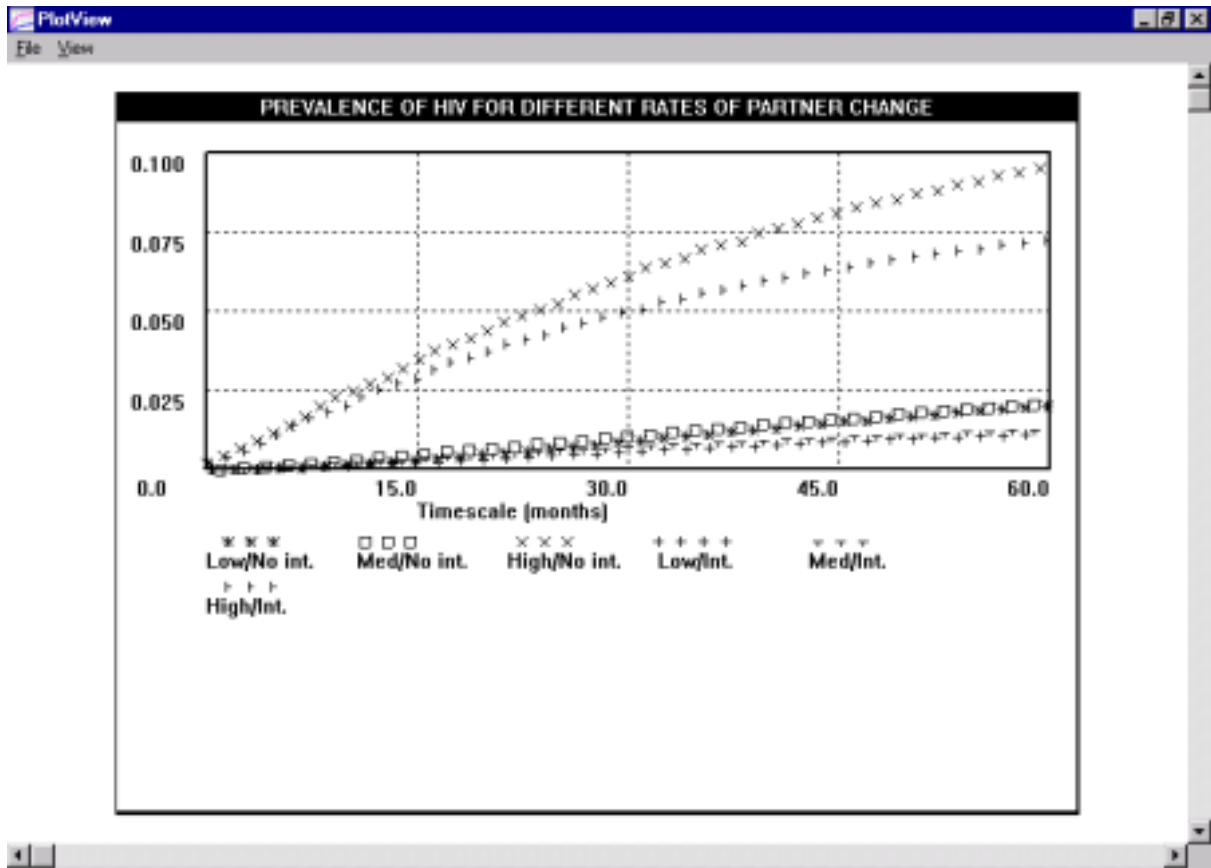
**STI PREVALENCE** - plots a graph of projected trends over time of STI prevalence (range 0 to 1) among boys and girls. The graph shows the projected prevalence of STI infection, on the vertical axis, for boys and girls both with (After) and without (Before) the intervention. The vertical axis can be scaled to an appropriate value.



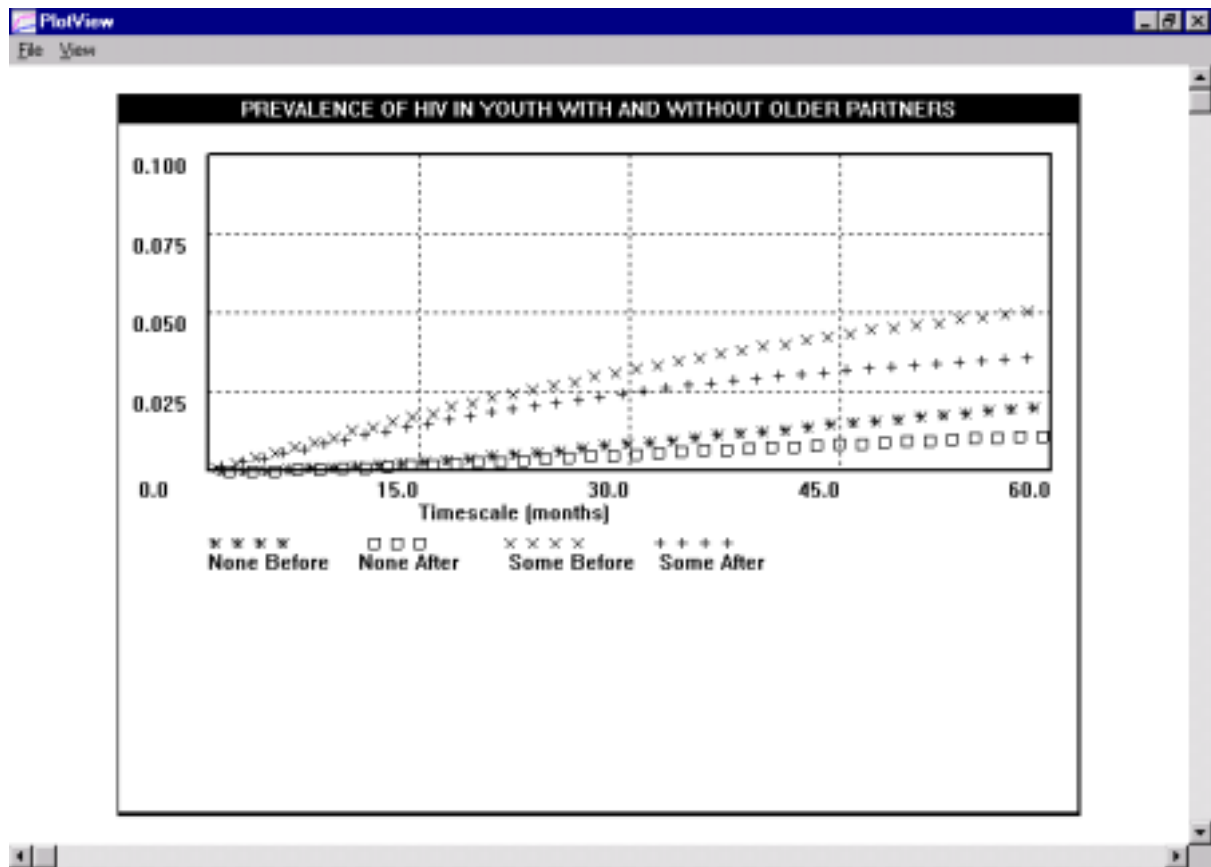
**PREVALENCE HIV REACHED / NOT REACHED YOUTH** – plots a graph of projected trends over time of HIV prevalence (range 0 to 1) among youth reached and not reached by the intervention. The graph shows, on the vertical axis, the projected prevalence of HIV infection among boys and girls reached and not reached by the intervention.



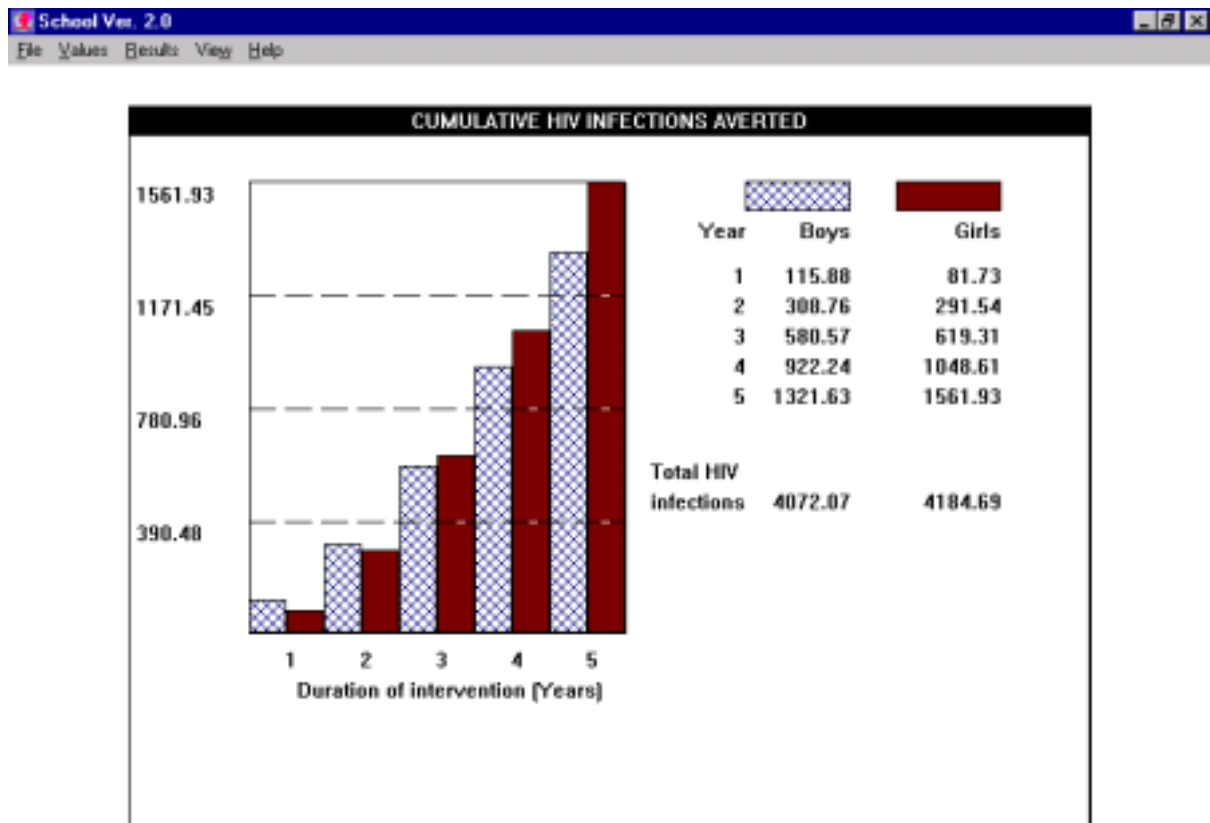
PREVALENCE HIV BY DIFFERENT RATES OF PARTNER CHANGE – plots a graph of projected trends over time of HIV prevalence among boys and girls (range 0 to 1) with different rates of partner change, with and without the intervention.



PREVALENCE HIV IN YOUTH WITH AND WITHOUT OLDER PARTNERS – plots a graph of projected trends over time of HIV prevalence among boys and girls (both with and without the intervention) according to whether youth have older partners, of patterns of mixing or patterns of condom use.



**INFECTIONS AVERTED** - plots a bar graph of the projected cumulative number of HIV infections averted among boys and girls (including both in and out of school youth) due to the intervention. The graph shows the estimated cumulative number of HIV infections averted on the vertical axis for girls (solid dark bars) and boys (shaded bars), for each year of the intervention (horizontal axis). The corresponding figures for each year are shown in the accompanying table. The projected number of HIV infections occurring for boys and girls over the timeframe being considered is also shown.



**SUMMARY SHEET** - shows an outline of the main inputs, estimated values and outputs of the model.



| MAIN DESCRIPTIVE STATISTICS                         |           |                |          |                       |          |
|---|-----------|----------------|----------|-----------------------|----------|
| YOUTH   |           | OLDER PARTNERS |          | INTERVENTION COVERAGE |          |
| Total Youth   | 100000.00 | HIV prev       | 50.00    | In School             | 0.50     |
| Prop. in school                                     | 0.50      | STI prev.      | 12.50    |                       |          |
| BEHAVIOURAL INPUTS                                  |           |                | BEFORE   | AFTER                 |          |
| Prop. boys having older partners                    |           |                | 0.44     | 0.40                  |          |
| Prop. girls having older partners                   |           |                | 0.28     | 0.26                  |          |
| Average number. of partners per year: boys          |           |                | 1.55     | 1.43                  |          |
| Average number of partners per year: girls          |           |                | 0.75     | 0.73                  |          |
| DISTRIBUTION OF CONDOM USE WITH ADULTS              |           |                | BEFORE   | AFTER                 |          |
| With older partners: None                           |           |                | 0.30     | 0.24                  |          |
| With older partners: Half                           |           |                | 0.03     | 0.04                  |          |
| With older partners: All                            |           |                | 0.03     | 0.05                  |          |
| Av. condom use of youth/youth partnerships          |           |                | 0.20     | 0.30                  |          |
| PROJECTED TOTAL CONDOMS USED (1000'S) IN 5.00 YEARS |           |                |          |                       |          |
| No interv   | 12147.57  | With interv    | 36145.65 | Difference            | 23998.08 |
| FINAL HIV PREVALENCE (%)                            |           | No interv      |          | With interv           |          |
|   |           | boys           | girls    | boys                  | girls    |
| No older partners                                   |           | 1.18           | 2.74     | 0.60                  | 1.58     |
| Older partners: NONE                                |           | 5.71           | 4.94     | 4.53                  | 3.49     |
| Older partners: HALF                                |           | 4.35           | 4.31     | 3.14                  | 2.59     |
| Older partners: ALL                                 |           | 2.67           | 3.84     | 1.63                  | 2.22     |
| HIV INFECTIONS AVERTED IN 5.00 YEARS                |           |                |          |                       |          |
| Boys  | 1321.63   | Girls          | 1561.93  | Total                 | 2883.56  |
| HIV INFECTIONS IN 5.00 YEARS WITHOUT INTERVENTION   |           |                |          |                       |          |
| Boys  | 4072.07   | Girls          | 4184.69  | Total                 | 8256.75  |

## INPUTS

The inputs displayed give an overview of the school population, the older partners of the children, and the coverage of the intervention amongst the school population

|                          |  |
|--------------------------|--|
| Total Youth              | Input size of overall youth population                           |
| Prop. in school          | Input proportion of youth population that are in school          |
| Older partners: HIV prev | HIV prevalence of older partners of the youth population         |
| Older partners: STI prev | STI prevalence of older partners of the youth population         |
| Coverage, in School      | Coverage of school intervention amongst youth that attend school |

## Behavioural inputs

|   |   |
|---|---|
| Prop. boys having older partners          | Proportion of boys that have adult partners                 |
| Prop. girls having older partners         | Proportion of girls that have adult partners                |
| Average number of partners per year: boys | Average number of sexual partners that a boy has in a year  |
| Average number of partners per year: girl | Average number of sexual partners that a girl has in a year |

#### **Distribution of condom use with adults**

|  |   |
|--|---|
| With older partners: None                  | Proportion of youth population that have older partners but do not use condoms          |
| With older partners: Half                  | Proportion of youth population that have older partners and use condoms half of time    |
| With older partners: All                   | Proportion of youth population that have older partners and use condoms all of the time |
| Av. Condom use of youth/youth partnerships | Average consistency of condom use amongst youth sexual partnerships                     |

## **OUTPUTS**

The outputs displayed give an overview of how the intervention has increased overall levels of condom use. They also show the predicted effect of this change on the prevalence of HIV infection among different sub-groups and the number of averted HIV infections. The main headings and outputs are:

### **Projected total condoms used (1000's) in 'timeframe' years**

The total projected number of condoms used by the youth in the timeframe considered, with and without the intervention. The increase will result both from change in sexual behaviour and in the consistency of condom use. Consequently, the overall figure could be positive or negative, and still have a beneficial impact on HIV transmission.

### **Final HIV prevalence**

In this section, the HIV prevalence after the timespan of the intervention is predicted with and without the intervention for males and females in different risk groups.

|                   |  |
|-------------------|--|
| No older partners | HIV prevalence amongst youth that do not have older partners |
|-------------------|--|

|                      |  |
|----------------------|--|
| Older partners: NONE | HIV prevalence amongst youth that have older partners but do not use condoms           |
| Older partners: HALF | HIV prevalence amongst youth that have older partners and use condoms half of the time |
| Older partners: ALL  | HIV prevalence amongst youth that have older partners and use condoms all of the time  |

#### **HIV infections averted in 5.00 years**

Total HIV infections averted for boys and girls in and out of school

#### **HIV infections in 5.00 years without intervention**

Total HIV infections amongst boys and girls in and out of school



## Appendix 1: Check list of input parameters needed by SCHOOL, Version 2.0.

| Data input type            | Data inputs   | Default value |       |
|----------------------------|---|---------------|-------|
|                            |   | Boys          | Girls |
| Epidemiological inputs     | Average STI duration for boys and girls (months) 2                      | 1.0           | 1.0   |
|                            | Average duration of high viraemia phase (months)                        | 1.5           |       |
|                            | Average duration between HIV infection and severe morbidity (months)    | 84            |       |
|                            | Older partners HIV prevalence for males and females                     | 40%           | 60%   |
|                            | Older partners STI prevalence for males and females                     | 10%           | 15%   |
|                            | Proportion of older partners with high viraemia                         | 10%           | 10%   |
| Transmission probabilities | Probability of HIV transmission per sex act for male to female 3        | 0.002         |       |
|                            | Probability of HIV transmission per sex act for female to male 4        | 0.001         |       |
|                            | Probability of STI transmission per sex act both sexes 5                | 0.35          |       |
|                            | Average STI cofactor per sex act 6                                      | 30            |       |
|                            | Multiplicative factor to transmission rate during high viraemia phase 7 | 10            |       |
|                            | Condom efficacy per sex act   | 0.9           |       |

---

2 STI duration is dependent on the local access to health services

3 HIV transmission rate for male to female, see refs. European study group 1992

4 HIV transmission rate for female to male, see refs. Haverkos *et al.* 1992 and Padion *et al.* 1991

5 STI transmission rate, see refs. Hook & Marra 1992, Hethcote & York 1984, Over & Piot 1996

6 STI cofactor for HIV transmission, see refs Laga *et al.* 1993, Hayes *et al.* 1995, Cameron *et al.* 1989, Plummer *et al.* 1991

7 High viraemia cofactor for HIV transmission, see refs Cohen *et al.* 1997, Pinkerton & Abramson 1996, Jacquez *et al.* 1994

| Data input type                                    | Data inputs  |        | Default value |       |
|--|--|--------|---------------|-------|
|  |  |        | Boys          | Girls |
| Size of youth population and intervention coverage | Average age reached school youth start sex   |        | 16            | 15    |
|  | Average age not reached school youth start sex   |        | 16            | 15    |
|  | Average age not reached school youth enter regular partnerships  |        | 18            | 17    |
|  | Average age reached school youth enter regular partnerships  |        | 18            | 17    |
|  | Total number of youth in age range   |        | 50000         | 50000 |
|  | Proportion of youth in school for boys and girls   |        | 0.55          | 0.45  |
|  | Proportion of school youth reached by intervention for boys and girls  |        | 0.5           | 0.5   |
| Fixed behavioural inputs                           | Definition of low, medium and high number of partners per month for boys and girls   | Low    | 0.5           | 0.5   |
|  |  | Medium | 1.0           | 1.0   |
|  |  | high   | 5.0           | 2.0   |
|  | Definition of 'NONE', 'SOME' and 'ALL' condom use for youth/adult partnerships   | NONE   | 0.1           |       |
|  |  | SOME   | 0.4           |       |
|  |  | ALL    | 0.9           |       |
|  | Average number of sex acts per month for youth/youth relationships   |        | 10            |       |
|  | Average number of sex acts per month for youth/adult relationships   |        | 5             |       |
|  | Adjustment factor for differences in boys/girls reporting of sexual behaviour  |        | 0.5           |       |
|  | Level of like with like mixing between boys and girls by sexual activity   |        | 0.5           |       |
| Sexual activity of youth                           | Population distribution of levels of sexual activity for reached youth (sexual activity is either low, medium or high)     | Low    | 0.6           | 0.5   |
|  |  | Medium | 0.8           | 0.7   |
|  |  | high   | 0.3           | 0.3   |
|  | Population distribution of levels of sexual activity for not reached youth (sexual activity is either low, medium or high) | Low    | 0.15          | 0.2   |
|  |  | Medium | 0.1           | 0.2   |
|  |  | High   | 0.05          | 0.1   |

| Data input type  | Data inputs  |             | Default value |       |
|--|--|-------------|---------------|-------|
|  |  |             | Boys          | Girls |
| Proportion of youth that have adult partnerships                           | Proportion of reached youth that have older partnerships for low medium and high sexual activity     | Low         | 0.2           | 0.15  |
|  |  | Medium      | 0.4           | 0.3   |
|  |  | High        | 0.6           | 0.5   |
|  | Proportion of not reached youth that have older partnerships for low medium and high sexual activity | Low         | 0.3           | 0.2   |
|  |  | Medium      | 0.5           | 0.4   |
|  |  | High        | 0.7           | 0.6   |
| Proportion of partners that are adults given that they have adult partners | For reached youth of low, medium and high sexual activity  | Low         | 0.1           | 0.1   |
|  |  | Medium      | 0.3           | 0.2   |
|  |  | High        | 0.5           | 0.4   |
|  | For not reached youth of low, medium and high sexual activity  | Low         | 0.2           | 0.1   |
|  |  | Medium      | 0.4           | 0.3   |
|  |  | High        | 0.6           | 0.5   |
| Condom use in youth partnerships   | Average consistency of condom use for youth/youth partnerships for reached and not reached youth     | Reached     | 0.6           |       |
|  |  | Not reached | 0.2           |       |
|  | Population distribution of condom use within youth/adult partnerships for reached youth              | NONE        | 0.4           | 0.1   |
|  |  | SOME        | 0.2           | 0.4   |
|  |  | ALL         | 0.4           | 0.5   |
|  | Population distribution of condom use within youth/adult partnerships for not reached youth          | NONE        | 0.8           | 0.9   |
|  |  | SOME        | 0.1           | 0.05  |
|  |  | ALL         | 0.1           | 0.05  |

## References

- European Study Group on Heterosexual Transmission of HIV.** 1992. Comparison of female to male and male to female transmission of HIV in 563 stable couples. *British Medical Journal* 304: 809-813.
- Haverkos, H.W., Battjes, R.J.** 1992. Female to male transmission of HIV. *Journal of the American Medical Association* 268 (14): 1855-56.
- Padian, N.S., Shiboski, S.C., Jewell, N.P.** 1991. Female-to-male transmission of human immunodeficiency virus. *Journal of the American Medical Association* 266 (12): 1664-67.
- Hook, E., Marra, C.** 1992. Acquired syphilis in adults. *New England Journal of Medicine* 326: 1060-69.
- Hethcote, H.W., Yorke, J.A.** 1984. Gonorrhea transmission dynamics and control. *Lecture notes in Biomathematics*, Springer Verlag, New York.
- Over, M., Piot, P.** 1996. Human immunodeficiency virus infection and other sexually transmitted diseases in developing countries: Public health importance and priorities for resource allocation. *The Journal of Infectious diseases* 174(Suppl 2): S162-75.
- Laga, M., Manoka, A., Kivuvu, M. et al.** 1993. Non-ulcerative sexually transmitted diseases as risk factors for HIV-1 transmission in women: Results from a cohort study. *AIDS* 7(1): 95-102.
- Hayes, R.J., Shulz, K.F., Plummer, F.A.** 1995. The cofactor effect of genital ulcers on the per-exposure risk of HIV transmission in sub-Saharan Africa. *Journal of Tropical Medicine and Hygiene* 98: 1-8.
- Cameron, D.W., Simonsen, J.N., D'Costa, I.J. et al.** 1989. Female to male transmission of human immunodeficiency virus type 1: risk factors for seroconversion in men. *The Lancet* ii: 403-407
- Plummer, F.A., Simonsen, J.N., Cameron, D.W. et al.** 1991. Cofactors in male-female sexual transmission of HIV-1. *Journal of Infectious Diseases* 163: 223-239
- Cohen, M.S., Hoffman, I.F., Royce, R.A. et al.** 1997. Reduction of concentration of HIV-1 in semen after treatment of Urethritis: Implications for prevention of sexual transmission of HIV-1. *The Lancet* 349 (9069): 1868-73.
- Pinkerton, S.D., Abramson, P.R.** 1996. Implication of increased infectivity in early stage HIV infections. *Evaluation Review* 20(5): 516-40.
- Jacquez, J.A., Koopman, J.S., Simon, C.P., Longini, I.M.** 1994 Role of the primary infection in epidemics of HIV infection in gay cohorts. *AIDS* 7(11): 1169-84.

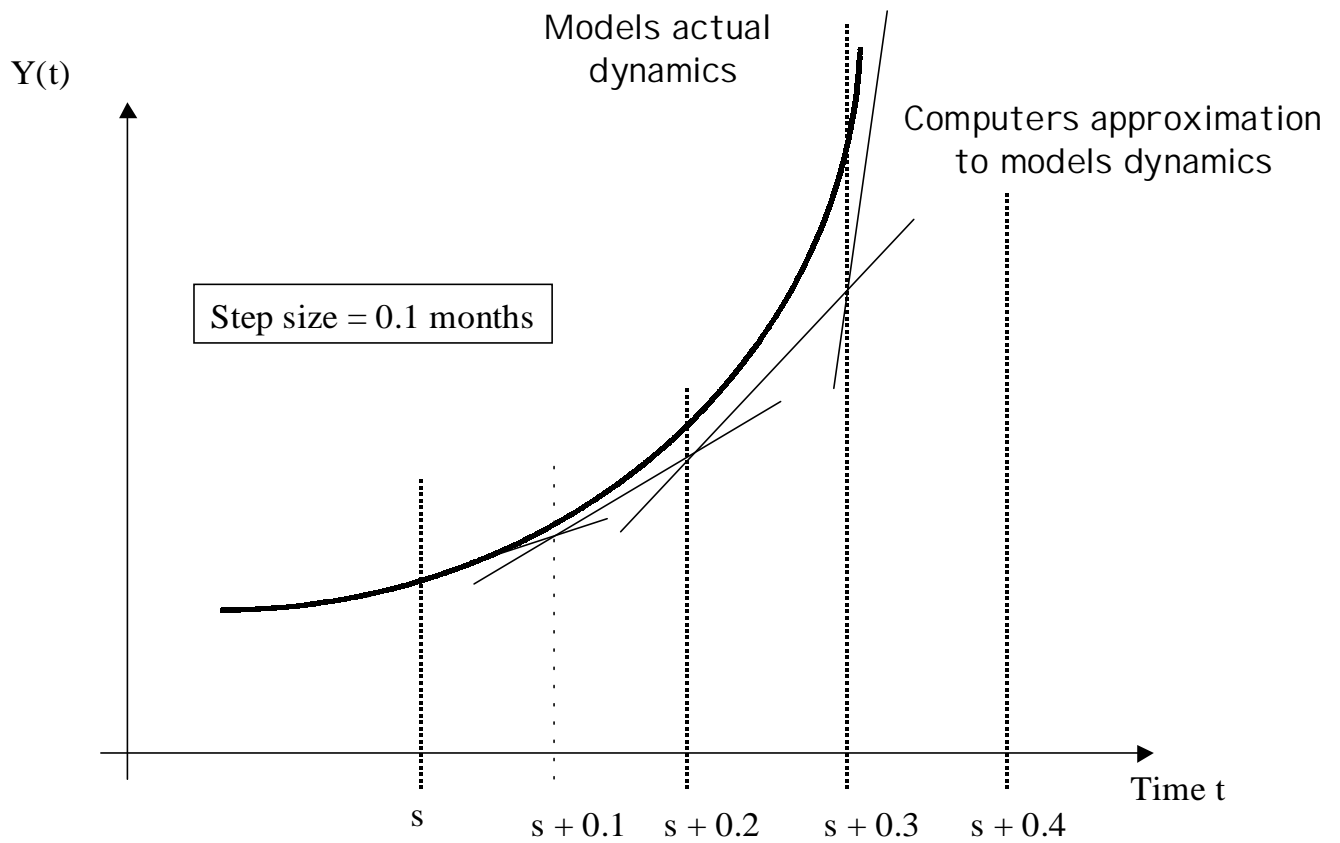
## Appendix 2: Effect of step size on the computers numerical approximation to the models dynamics

The model simulates the patterns of HIV and STI transmission between the groups targeted by the intervention and their sexual partners. Mathematically, the transmission process is described using methods from calculus. For this, a system of 'deterministic differential equations' are used to describe how, over time, we would expect HIV to be transmitted among the population. This is done by separating out the population being modelled into different sub-groups, according to their patterns of sexual behaviour and condom use (described using the behavioural input parameters), and according to their HIV infection status (either susceptible, infected with high viraemia, and infected with low viraemia). For each sub-group, the mathematical equations describe the rate of movement between the different HIV infection sub-groups, as those susceptible to HIV infection become infected, as those with high viraemia move into the low viraemia class, and as those with low viraemia become chronically sick and cease sexual activity. The rates of movement between these sub-groups are determined by the patterns of sexual behaviour and condom use, the distribution of STDs at that point in time, and the patterns of sexual contact between individuals in the different behavioural sub-groups.

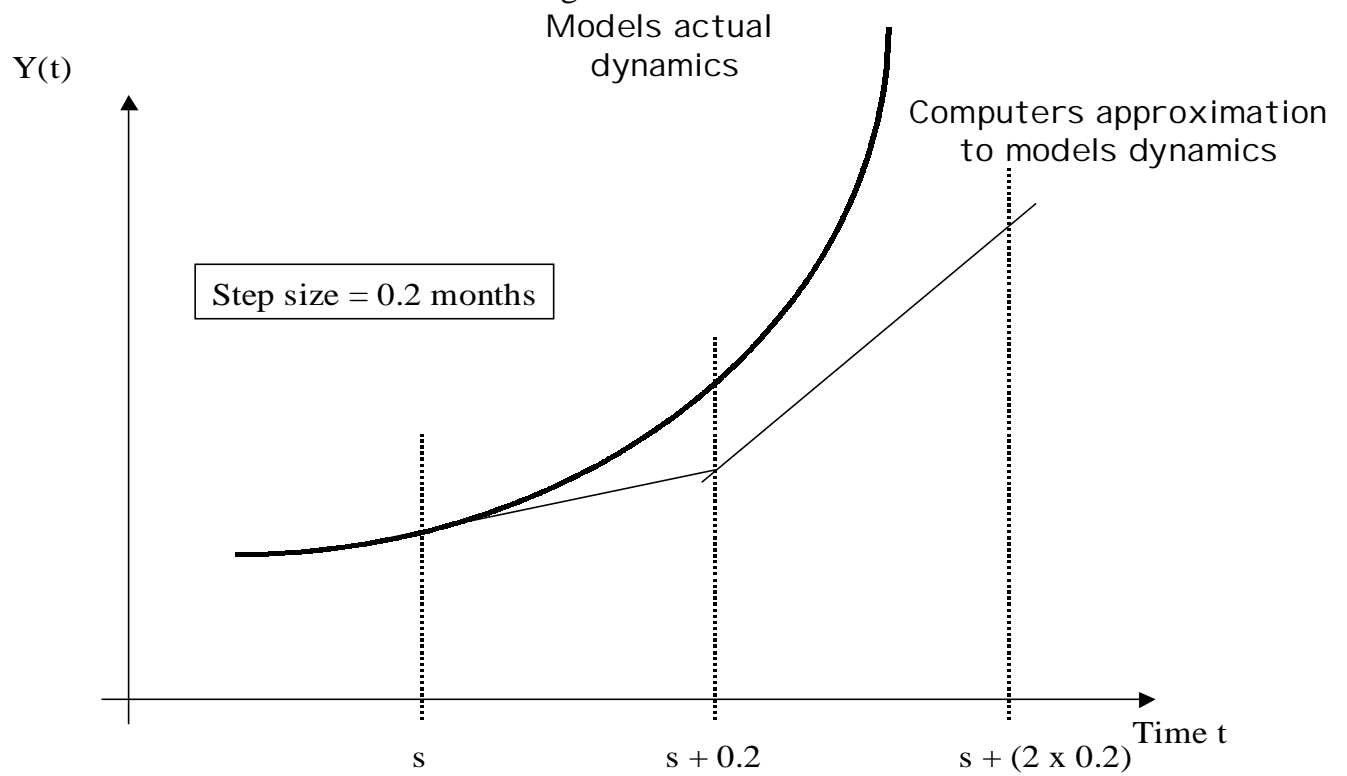
These equations describe the slope of the prevalence functions among the different behavioural sub-groups over time. They can be solved to obtain prevalence estimates in each sub-group over time. However, it is not possible to solve these equations algebraically. Instead, numerical methods are used to approximate the solution to them. This is done in a step by step manner (as shown in Figure A1). Starting off with the initial levels of infection (at time  $s$ ), the slope of each prevalence function is calculated using the differential equations. The prevalence value at the next point in time (say after 0.1 months) is estimated by using the value of the slope to draw a straight line through the initial prevalence value. This is used to approximate the true solution to the differential equation at the next point in time. The accuracy of this method of approximation depends on the size of the step size and the slope of the prevalence function. In general, the smaller the step size, the more accurate the solution. This can be seen by comparing Figures A1 and A2 below – which shows the true solution to the model, and the approximated solutions. In Figure 1 the step size is 0.1. In Figure A2 the step size is 0.2. As can be seen, as the step size is doubled from 0.1 to 0.2 months, the accuracy of the estimated solution decreases greatly.

Therefore, when using the model, it is important to try a range of step sizes, to ensure that the projected values are good approximations to the true solution to the model. The best way of doing this is outlined in the section headed 'step size'.

Figure A1. Estimating the solution to the model dynamics



's' is starting time in months



's' is starting time in months

## Appendix 3: *HIVTools* models and publications

### 1. Currently Available from UNAIDS

- *SexWork*: Models the impact of interventions focused on sex workers and their clients.
- *Blood*: Models the impact of the strengthening of blood transfusion services.
- *School*: Models the impact of interventions focusing on youth in school.
- *IDU*: Models the impact of strategies to reduce HIV transmission among injecting drug users.
- *Costing Guidelines for HIV/AIDS Prevention Strategies*
- *Costing Guidelines for HIV/AIDS Prevention Strategies Among Injecting Drug Using Populations*.

### 2. Publications

Kumaranayake L, Pepperall J, Goodman H, and Mills A. (1998) *Costing Guidelines for HIV/AIDS Prevention Strategies*. UNAIDS Best Practice Collection - Key Materials.  
<http://www.unaids.org/highbrand/document/economics/index.html>.

Kumaranayake, L. Mangtani P, Boupda-Kuate A, Foumena Abada JC, Cheta C, Njoumeme Z and Watts C. (1998) *Cost-Effectiveness of a HIV/AIDS Peer Education Programme Among Commercial Sex Workers: Results from Cameroon*. Presented at the XII World AIDS Conference, Geneva, 28 June - 3 July.

Mills A and Watts C. (1996). *Cost-effectiveness analysis of HIV prevention alternatives and the role of government*. Paper presented to the workshop >AIDS and development: the role of government=. Chateau de Limelette, Brussels, 17-19 June.

Watts C, Goodman H and Muyinda G. (1995) Estimation of the number of HIV infections averted by screening of blood. *The Lancet* 346: 783-4.

Watts C, Goodman H, Muyinda G, Msiska R, Mulenga D, Bertozzi S and Mills A. (1995) *Estimating the costs and impact of strengthening blood transfusion services in Zambia*. Abstract presented at the IXth International Conference on AIDS and STDs in Africa, Kampala, 10-14 December.

Watts CH. (1997) *Microbicides for HIV prevention: imperfect results and public policy*. Background paper for symposium on Practical and Ethical Dilemmas in the Clinical Testing of Microbicides. Women=s Health Advocates on Microbicides/The Population Council, Washington, USA.

Watts C and Kumaranayake L. (1999) Thinking big: scaling-up HIV-1 interventions in sub-Saharan Africa. *The Lancet* 354: 1492.

Kumaranayake L, Watts C. Moderating discussions on the web: opportunities, challenges and lessons learned Forthcoming *Health Policy and Planning* March 2000.

Kumaranayake L, Watts C. *Costs of Scaling HIV Program Activities to a National Level for Sub Saharan Africa: Methods and Estimates*. Forthcoming Washington, DC: World Bank.

Walker D, Vickerman P, Kumaranayake L et al. (1999). The importance of early intervention for HIV/AIDS prevention: The example of Belarus. Forthcoming *Mir Meditsiny* (in Russian).

### 3. In progress

Watts C and Vickerman P. *SexWork*: new software to estimate the impact of interventions focused on sex workers on their clients.

Kumaranayake L, Watts C, Vickerman P *et al*. Replication and costs of replicating interventions in Cameroon.

Watts C, Vickerman P, Vaughan P *et al*. What matters?: key factors influencing the impact of interventions focused on sex workers and their clients.

Vickerman P and Watts C. *IDU*: a user-friendly model to estimate the impact of HIV interventions among injecting drug users.

Kumaranayake L, Vickerman P, Walker D *et al*. The cost-effectiveness of HIV preventive measures among injecting drug users in Svetlogorsk, Belarus.

Kumaranayake L, Walker D, Dickun et al. Harm reduction activities among injecting drug users in Belarus: a cost analysis.

Vickerman P and Watts C. HIV education for youth in school: a tool (SCHOOL) to model intervention impact.

Watts C, Kumaranayake L, Vickerman P *et al*. The cost-effectiveness of HIV interventions in sub-Saharan Africa for youth in school.

Kumaranayake L *et al*. The costs of in and out of school HIV interventions in Cameroon.

Watts C, Goodman H, Kumaranayake L *et al*. Factors influencing the cost, impact and cost-effectiveness of initiatives to strengthen blood transfusion services.